Integrated promotion of the biodiesel chain

COMPARATIVE STUDY OF THE CURRENT CULTIVATION PRACTICES AND ENERGY CROPS

Intelligent Energy Europe

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EIE/06/167 SI2.448457

Project *PROBIO*

TABLE OF CONTENTS

1. INTRODUCTION AND AIMS

PROBIO European Project **with contract number EIE/06/167/SI2.448457,** co financed by the program "Intelligent Energy-Europe" (IEE), on the energies use from renewable sources based and the greenhouse effect gas reduction persecutes by means the biodiesel integral strategy development in the European Union countries.

The main aim is to analyze current cultivation practices and energy crops in five regions in particular: provinces of Burgos, Ávila and Huelva (Spain) and regions of Pomurje (Slovenia) and Abruzzo (Italy) and to describe the crop potential in this regions, according to their weather and geographical conditions.

1.1 Some aspects related to Crops intended to obtain biofuel

This comparative study is based on studies from five regions that were made developing 3 main actions, such as documentation and information search, compiled information study and analysis, and final document elaboration. The studied and analyzed scopes, from both secondary (existing) and primary information (specially generated to this study), were as follows:

- Definition, classification, geographical and seasonal crop distribution
- Species and varieties used in tests experimentation
- Crop practices analysis
- Tests and experimentations outcomes analysis
- Crops and transformation costs economic analysis
- Acceptability from farmers and potential of available to crop area and potential of oils production
- Sustainability indicators, energy and environmental balances, and impact of these crops on soil diversification and fertility

2. CROPLAND DATA

Cropland data are summarized for each region (Burgos, Avila, Huelva, Pomurje and Abruzzo) according to their specific conditions separately.

2.1. BURGOS (SPAIN)

2.1.1 Sunflower

There is a high variation from one season to another one on the cultivated areas, having increases near the 25%, and falls at about the 37% with regards to middle cultivated area, with the lower figure in 2000 and the higher in 2003 and 2006.

YEAR	UNIRRIGATED LAND	IRRIGATED LAND	TOTAL (ha)
2000	20774	439	21213
2001	35874	1247	37121
2002	27519	495	28014
2003	40765	892	41657
2004	32471	616	33087
2005	30981	542	31523
2006	40137	594	40731

Table 1: Cultivated sunflower area (ha) in Burgos Province during lasts seasons

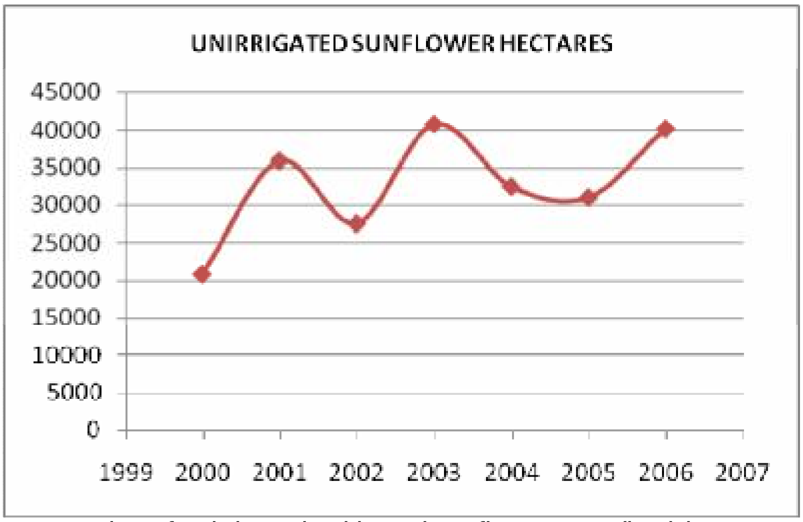


Diagram 1: Progression of unirrigated cultivated sunflower area (has) in Burgos Province during last seasons

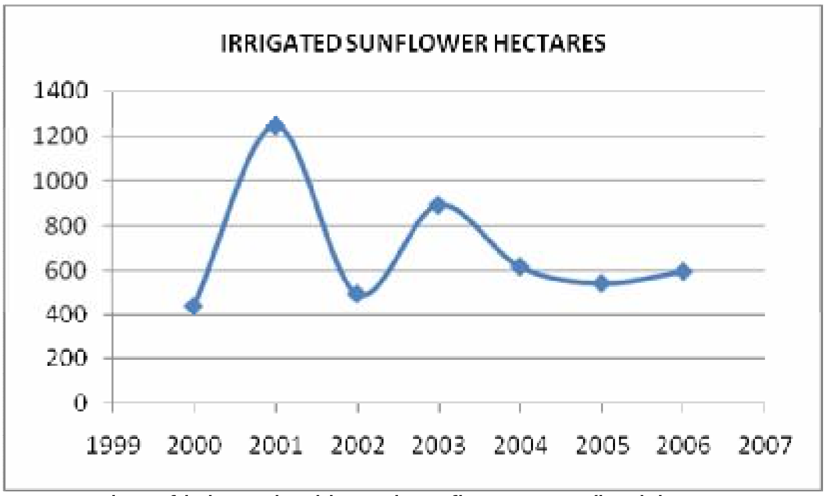


Diagram 2: Progression of irrigated cultivated sunflower area (has) in Burgos Province during last seasons

2.1.2 Rape

As we can see on the following data and diagram 3, almost the whole rape cultivated area last years in Burgos Province is irrigated. Excepting the huge fall on 2005, the progression is positive from 2002, being up to 600 has in 2006.

YEAR	UNIRRIGATED LAND	IRRIGATED LAND	TOTAL
2000	56	0	56
2001	16	0	16
2002	103	0	103
2003	125	0	125
2004	383	0	383
2005	215	1	216
2006	560	0	560

Table 2: Cultivated rape area (ha) in Burgos Province during lasts seasons

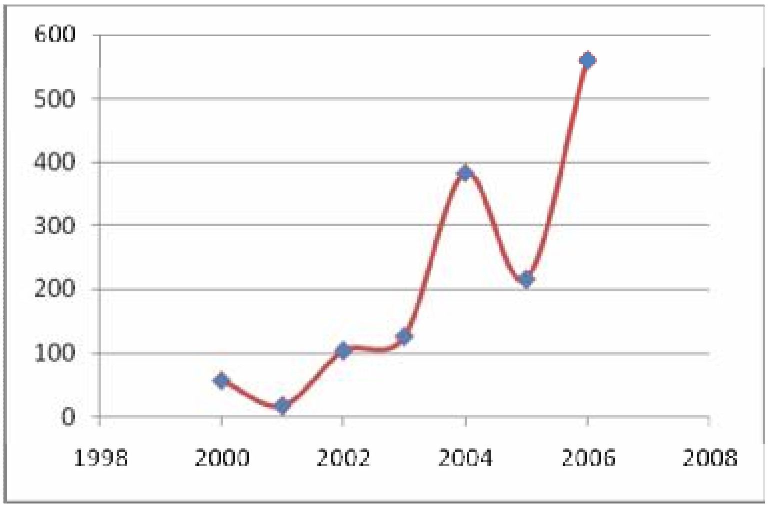


Diagram 3. - Progression of irrigated cultivated rape area (has) in Burgos Province during last seasons.

2.1.3 Conclusions

Conclusions concerning the study of the current situation are presented organized by the 3 analyzed scopes, that is, agrarian experimentation tests, crops economic analysis and transformation costs analysis.

Concerning agrarian experimental tests, although data from the last 3 seasons are not representative to reach coherent conclusions, it was noticed that the lack of rain during the crop development had more limiting effect on the production than the proposed varieties to be tested.

Productions have considerably lowered on the autumn rape crop, when there are harsher conditions, low and bad shared rainfalls, as on 2005-2006 season. By zones, varieties ***Hercules*** and ***Hybrystar*** (hybrid varieties) and ***Recital*** (non hybrid) have a prominent position in La Ribera region productions. Varieties ***Hercules, Es betty*** (hybrid) and ***Corail*** and ***Potomac*** (non hybrid) are the most prominent in Arlanza region. However, when conditions are less ad verses, and water from whether irrigation or rain in crop key moments, an increase of 1200 kg/ha is noticed. In La Ribera region Hornet variety stands out, with 7500 kg/ha, followed by Nelson, Es Saphyr, Es Hydromel, Vectra (6500 Kg/ha) hybrid varieties, and Nk Bravour and Recital (non hybrid varieties), with performances at about 6500 kg/ha. In Arlanza region stand out once again Hornet variety (5250 kg/ha) and, Royat, Luprina and Dante variety, with less production (4500 kg/ha). In Pisuerga area, Royat, Cornex, Libri and Es Hydromel varieties, which were less performing (3600 kg/ha) than in other regions, but it must be noticed the higher fat content (50%), over the percentages obtained by these varieties in other neighbor areas.

Tests made by Cooperatives were made with some varieties turned out interesting because of their production and fat content, such as ***Royat*** and ***Madrigal*** (from Koipesol), and ***Libri*** (from Causade).

Concerning spring rape crop, considering the production results, it is interesting to use ***Jura variety*** (hybrid) and ***Forte***, ***Valle de Oro*** and ***Licosmos*** (non hybrid varieties) in La Ribera area when sowing time is delayed.

Sunflower tested varieties by the Public Administration in Burgos Province were 14 croplands classified as high oleic and other 25 classified as normal croplands (from which there is no data to be analyzed). It is necessary to explain that the tested varieties by the Cooperatives in Burgos areas are not the same as the ones proposed by the Public Administration.

Regarding crop economic analysis, the final conclusion is the costs differences are due to the practices used in each cropland more than because of their geographical situation. Besides, the main parameters of rape production costs variation (in consulted cultivations) are due to the preparatory land work depth, the kind of seed and the irrigation.

The rape cultivation break-even point shows that it will not be profitable to returns under 1.141,5 Kg/ha in unirrigated lands and 1.768,5 Kg/ha in irrigated lands, before grants.

After crops transformation to biofuel costs analysis, especially on the first phase of the industrial process (oil extraction) it seems very probable that the extraction is developed by whether big and traditional extracting plants, dedicated to oil for food or new big industries, in such a way as smaller plants should resort to the bigger ones to make the extraction in better economic conditions.

The biofuel producers feasibility will depend on prices level will depend on the prices level of diesel oil from petroleum in petrol stations and oil for food. Because of that, the best chances to face this changing market will come from the Cooperatives (or entities including farmers in their projects) that have the chance to agrarian producers form part of global projects where there is a distribution of profits between both parts and both of them satisfy their profitability needs.

Conclusions referring to the potentials of theses crops show that the main agronomic potential pointing at biofuel production in Burgos Province is located in ***Arlanza, Pisuerga, La Bureba regions***, and in a lesser extent, La Ribera and Burgos area. In those regions there is an obvious vocation oriented to oil crops, reaching some very competitive profitability, not only in a regional level but also in a national one.

The success on introducing more biofuels in Burgos Province will depend not only on the cultivations agronomic aptitude, but also on the adaptation of different levels of risk their production implies. Concerning that meaning, the cultivation structural components are very important, such as the size, education level and risk aversion of the agrarian businessman in order to ensure a crops better adaptation.

The new horizon that will be opened concerning CAP policy is not clear; even some sectors predict the disappearance of direct grants. The second pillar, rural development, might be the responsible of the impulse for those crops. That would implies a producer change of mentality, as the only way to benefit from the subventions might be having an active participation on the transformation and putting the raw material on the market process.

The contractual link between producers and transformers is the key to have success on this sector. Price received by the farmer must ensure a minimum crop profitability, as well as to make up for higher risk taken by producer at the moment he prefer those crops which price depends on different elements, mostly of them beyond the control of the sector. It is necessary that the transformers develop some kind of contract ensuring that these crops are produced, without giving up the current revenues. A long term contract based on a right to buy would be much appropriated.

More little producers, but with more stable results due to the subventions and fallow lands, are the most interesting to the industry, as they ensure a stable provision, and they must dedicate more efforts than to others. As well, these producers are the more contributors to the rural development, since they are marginal producers, with a higher risk of giving up in case of the current CAP subventions stopped.

Biofuel production potentials in Burgos Province are the result to sum the whole producer ability from every industrial facilities existing. Factories production abilities are 80000 t/year (short term), taking into account that 10% of this quantity (8000 t/year) correspond to a currently working plant. This capacity offers, in a closed horizon, a wide range of chances to absorb the Province oil energy crops production without looking at other territories, as taking 2,6 Kg of grain to produce 1 Kg of oil, the industries ability might demand 30000 T of oil crops grain, equivalent to 25000 ha of unirrigated lands with a production of 1,2 T/ha, a quantity very far from the cultivated lands nowadays (at about 2800 ha of sunflower and approximately 90 ha of rape in 2007).

Acceptability of crops aiming biofuel production from farmers is not satisfying, due to the current situation. Although farmer shows his adaptation to new crops, these ways were taken based on the profitability. Next season, energy cultivations will be hardly reduced, because of the dependence on grants (to reach the profitability with these crops) and the miss of attraction to farmers due to the gap between food and non food cultivations.

Sustainability indicators show that, in those indicators related to resources consumption (needs of surface and fertilizers), sunflower is the crop that causes less environmental impact, due to its less surface and nutrients needs. As well, sunflower is the most energy efficient, so it is the crop from more energy is obtained from the same quantity of primary energy. Finally, biofuel coming from sunflower is which produces less quantity of greenhouse effect gazes. At the same time, it avoids a higher quantity of emission, using this biofuel instead of fossil fuel.

Regarding to the impact of these crops on soil diversification and fertility, the analysis about some different aspects, such as loss of biodiversity, crop rotation, selection criteria, predictable evolution, determines that the unavoidable oil crops presence on the rotations, both in unirrigation and irrigation, will add diversity and will improve soil fertility and physic conditions. On the other side, rape is established as head of rotation, both in unirrigation and irrigation (in competition with maize because of its demand and production ability), as it is the oil crop with more future expectations due to its production potentials, soil improvement ability, national and international demand, as well as the ideal quality of its oil to produce biofuel, according to the EU regulation.

3.1.4 Strategies to be proposed

The current situation strict analysis and future crops to biodiesel production in Burgos Province prospect entail the starting point to build some strategies that let these crops to be dynamized. The development of these strategies must be considered to and for the agrarian and transformer sector. It is necessary to exclude other probable strategies related to other implicated sectors, such as agrarian machinery production, consumers, Administration…

The aim of these strategies is to promote energy crops to obtain biofuel as energy alternative and a chance to the rural development. The Research group responsible of this study have considered, in this process, secondary and primary information (generated ad hoc, such as survey to farmers, technical employees, agrarian organizations, Public Administration).

The defined strategies are as follows:

- To promote ***medium sized facilities*** linked to grain production and self-consumption, as prototype of biodiesel producer
- ***Actions pointing at farmers*** in order to ensure production and consumption
- Improvement of ***energy balances on biodiesel production***
- ***Promote R&D*** in vegetal and industrial production fields
- ***Education and continuous advice*** to farmers

2.2. ÁVILA (SPAIN)

2.2.1 Sunflower

There is a high variation from one season to another one on the cultivated areas, having increases near the 20%, and falls at about the 32% with regards to middle cultivated area, with the lower figure in 2005 and the higher in 2002 and 2003.

YEAR	UNIRRIGATED LAND	IRRIGATED LAND	TOTAL (ha)
2000	8987	793	9780
2001	8580	1042	9622
2002	9404	868	10272
2003	9850	1131	10981
2004	8887	919	9806
2005	5663	606	6269
2006	6814	810	7624

Table 1: Cultivated sunflower area (ha) in Ávila Province during lasts seasons.

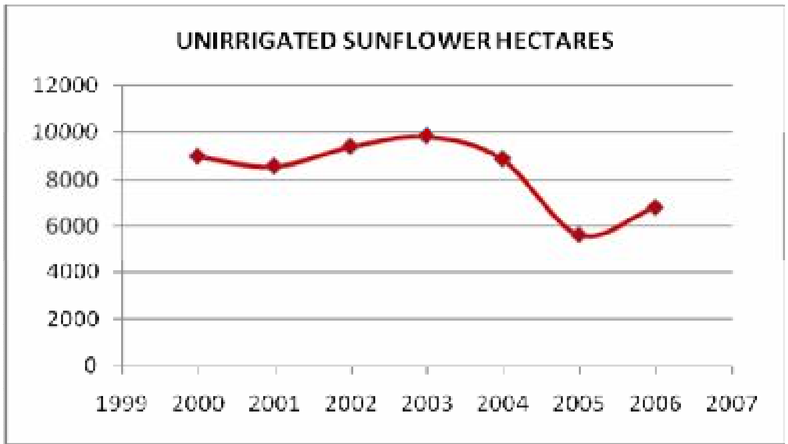


Diagram 1: Progression of unirrigated cultivated sunflower area (has) in Ávila Province during last seasons

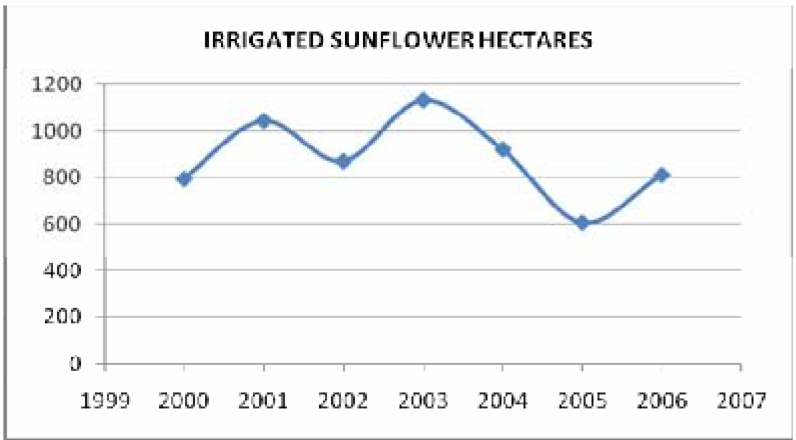


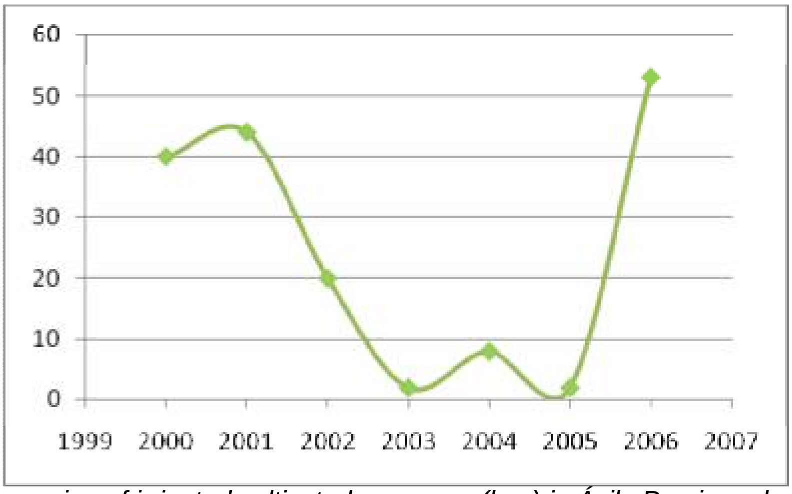
Diagram 2: Progression of irrigated cultivated sunflower area (has) in Ávila Province during last seasons

2.2.2 Rape

Rape cultivated area in Ávila Province last years was very limited, especially in unirrigated lands, with no more than 53 ha in any year. As we can see on the following data and diagram 3, cultivated surface was insignificant during 2003, 2004 and 2005.

YEAR	UNIRRIGATED LANDS	IRRIGATED LANDS	TOTAL
2000	0	40	40
2001	9	35	44
2002	0	20	20
2003	2	0	2
2004	4	4	8
2005	2	0	2
2006	19	34	53

Table 2: Cultivated rape area (ha) in Ávila Province during last seasons



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Seventeen rape varieties have been tested by the Public Administration (in the agrarian experimental tests), sowed in spring time. There is no production data that can help us to decide the most appropriate variety. However, it should be interesting to have production data from 3 or more seasons, in different parts of the Province, in order to arrive at coherent conclusions.

On the other hand, data from tests in Arévalo-Madrigal region, about autumn rape, compiled by ACOR, show ***Es Es Hydromel, Nk Nelson, Mascot, Carinata, Heros and Es Hydromel*** varieties as the most productives in unirrigated lands, and ***H1005, Grizzli, Jura, Forte, Valle de Oro and Kabel*** varieties in irrigated lands, during 3 seasons. Besides, production differencies in irrigated or unirrigated lands have fluctuated between 150 kg/ha, 700 kg/ha and 1700 kg/ha, respectively, for the 3 seasons when the tests have been made.

ACOR has also tested spring rape (irrigated and unirrigated lands) in Ávila Province, with lower returns on short cycle rapes, and finding no differences between irrigated or unirrigated varieties, standing out RG 405/10, Katia and Hunter (2) varieties.

Referring to sunflower cultivation, some tests have been made by the Public Administration during 3 years, in Arévalo-Madrigal area. In 2004 season, standed out ***Vidoc and Joana varieties*** (2500 Kg/ha). Whereas there were a loss of returns in 2005 and 2006, with ***Jalisco, Tromba and Sanay*** as the most productive varieties (at about 1700 Kg/ha). Returns obtained by tests with different sunflower varieties high oleic were lower than normal varieties. However, most productive varieties were ***Grasoli, Belmonte and R4H45*** (1500 Kg/ha).

Regarding crop economic analysis, the final conclusion is the costs differences are due to the practices used in each cropland more than because of their geographical situation. Besides, the main parameters of rape production costs variation (in consulted cultivations) are due to the preparatory land work depth, the kind of seed and the irrigation.

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Conclusions referring to the potentials of theses crops show that the main agronomic potential pointing at biofuel production in Ávila Province is located in ***Arévalo area***, where unirrigated lands returns are on the average of the Region. Besides, irrigated lands are growing, obtaining high and stables returns compared to the unirrigated lands. The middle size of these cultivations is little, an important limitation to the crop competitiveness in principle.

However, this area of Ávila is much closed to ACOR, which is an important support to their potentials, because the Cooperative is restructuring his activities towards biofuel production, betting on the sunflower and rape production between their members.

The success on introducing more biofuels in Ávila Province will depend not only on the cultivations agronomic aptitude, but also on the adaptation of different levels of risk their production implies. Concerning that meaning, the cultivation structural components are very important, such as the size, education level and risk aversion of the agrarian businessman in order to ensure a crops better adaptation.

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More little producers, but with more stable results due to the subventions and fallow lands, are the most interesting to the industry, as they ensure a stable provision, and they must dedicate more efforts than to others. As well, these producers are the more contributors to the rural development, since they are marginal producers, with a higher risk of giving up in case of the current CAP subventions stopped.

Biofuel production potentials in Ávila Province is the result to add the whole producer ability from every industrial facilities existing. In Ávila Province there is no evidence about investments projects in biofuel plants production. However, ACOR's plant, in Olmedo (Valladolid) could be considered as one of the Ávila Province in terms of potentials, due to its short distance. This plant has an ability of 70000 T/year, taking into account that it can make both parts of the process.

Acceptability of crops aiming biofuel production from farmers is not satisfying, due to the current situation. Although farmer shows his adaptation to new crops, these ways were taken based on the profitability. Next season, energy cultivations will be hardly reduced, because of the dependence on grants (to reach the profitability with these crops) and the miss of attraction to farmers due to the gap between food and non food cultivations.

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The aim of these strategies is to promote energy crops to obtain biodiesel as energy alternative and a chance to the rural development. The Research group responsible of this study have considered, in this process, secondary and primary information (generated ad hoc, such as survey to farmers, technical employees, agrarian organizations, Public Administration). The defined strategies are as follows:

STRATEGY 1: To promote medium sized facilities linked to grain production and self-consumption, as prototype of biodiesel producer

It is suggested to set up crops production, as well as the whole making process (including dosage, mixture and consumption) in geographical units as extended as plant annual capacity, in order to achieve the whole development of this strategy, on the transformation costs scope.

The best adapted model is the farmers association, specially the Cooperatives. This kind of organizations should be promoted, as well as a strengthening of which are established, so they can complete the process. Private companies using this schema (involving farmer on the industrial project) will have more chances on the future.

In any case, future plants will have to be adapted to make mixture of biodiesel and diesel oil, the last step. In Ávila region, it is recommended to link any project related to biodiesel fabrication with ACOR's project, situated on the nearness of its production area.

Concerning the use of Rural Development funds to promote these facilities, new LEADER initiatives established on the new Rural Development Program in Castilla y León, financed by EAFRD, should be an adequate instrument for the starting up. This way, areas with best potentials in energy crops might include this kind of proposals, as a way to reach development and economic diversification aims.

To do so, it is recommended that some information mechanisms to local population are set up, in order to involve them on the process. The population participation instruments starting up through LEADER initiatives have a wide experience in Castilla y León, so we think that they can be satisfactory to develop this action line, in such way as new gambles for these kind of projects.

From the beginning, the Region follows sector prevailing trends, that is the investment in or projects related to medium and big sized plants. But it should not be ruled out the possibility of small profitable facilities, such in other countries, integrated in big cultivation lands or as a result of production lands horizontal integration (natural persons or land cultivation Cooperatives), including them in production logistics development, transformation and consumption.

STRATEGY 2: Actions pointing at farmers in order to ensure production and consumption

Farmers always have shown they are ready to produce whatever somebody could propose them, with ensured productions (such as the studied crops) and prices.

Medium and long term contracts can contribute to a fidelity relationship between parts, especially for less competitive and more adverse to risks lands preferring stable incomes instead of a complete integration on economic liberalization, sector owner on the future.

New contracts should include risk, in such way as accorded compensation bonus would be able no only to cover production costs and provide some minimum incomes to the producer, but also internalize risks linked to market uncertainty.

Once again, Cooperative system (or participated companies) offer important possibilities not considered in non participated companies. Farmer's integration on transformer industry could suppose a continuous supplying with stable prices, out of the fluctuations.

In any case, it is necessary to integrate energy crops production and transformation steps, showing to the farmer the integrated cultivations added value.

On the other hand, it is necessary to encourage farmer to use biodiesel, informing about its advantages, financing motor tractors studies so they can see the good biodiesel operation, promoting, even adding, extras to Plan Renove grants (change of old drive equipments for new ones, from Agricultural Ministry). This popularization must be extended to consumer living on the influences areas of the project so it can promote biodiesel use.

Besides, it could be interesting to study the chances to encourage some kind of biodiesel use on the energy crops (or not) lands.

STRATEGY 3: Improvement of energy balances on biodiesel production

Some different ideas are proposed in order to reach this aim (some of them already mentioned) such as achieve the whole process in the same geographical place (cultivation, transformation and oil or biodiesel consumption), more reduced as possible, that let have an important economic and energy costs reduction on the transport.

In this sense, size optimization of oleaginous production lands that let setting up of biodiesel production profitable facilities, ensuring enough cultivation area to fuel own supplying, in some project no yet studied on the region, should be especially interesting.

STRATEGY 4: Promote R&D in vegetal and industrial production fields

To promote crops and varieties non food uses studies in order to obtain oils could be one of the best ways to reach this strategy, with species such as jatropha (imported plant, so unknown), or other autochthonous plants, maybe surprising potential biodiesel producers.

Different varieties of known species experimentations pointing at oil and biodiesel obtaining should be encouraged, so the more productive could be found, not only about the quantity but also quality for energy industry, taking into account weather and soil province conditions, in different sowing dates.

It is necessary to add the convenience of permanent and serious experimentations in other known and not recommended today species (thistle, *carinata*…), thinking of its oil production using, not only as biomass.

Nowadays, experimentations are almost exclusively addressed to varieties productive characterization, and should be extended to other aspects as well as grain quality, sowing dates…, to production costs reduction, energy balance improvement, harvest loss reduction, fertilization optimization (smaller costs), etc.

In other sense, it is important to research about industry productive process optimization, looking for new additives improving oil and biodiesel characteristics, making possible its direct use without diesel oil mixture from petroleum, and without problems to the motor of equipments, as well as new by-products uses, especially glycerin.

STRATEGY 5: Education and continuous advice to farmers

Educational and information actions, addressed to farmers and technical experts, covering agricultural and productive process knowledge are proposed to reach this strategy, through courses, technical and popularization events…, coordinating actions in the province, and supporting technical assistance to farmers.

Education and technical assistance must be shown through studies about crop costs, optimization, most adequate farm works, best industrial quality harvest, etc., as well as actions referring to biodiesel uses popularization.

Education towards the making aware of energy saving need in agrarian sector, high energy efficiency self-propelled and drive equipments use, replacement of old equipments, farm works rational carrying out, etc. should be encouraged.

2.3. HUELVA (SPAIN)

2.3.1 Susceptible energy crops to be implanted

At the moment they are known more than three hundred oily species whose oil can be used to biodiesel production. At world-wide the most used they are rape, soybean, sunflower and african palm. In Central America, India and West Africa some areas is beginning to use jatropha and corozo palm by their high productions in oil.

Table 1.- Characteristics of some energy crops.

Crop	Energy crops (oily species)	Oil yield (Kg/ha)	Advantages/disadvantages
Known in Huelva province	Linun usitatissimun (flax) Carthamus tinctorius (safflower) Glicine max (soybean) Helianthus annuus (sunflower) Brassica napus (rape)	150 100 420 890 1.100	Well in dry land Leguminous Leguminous Well in dry land High production in irrigated
Unknown in Huelva province	Argania espinosa (argania) Jatropha curcas (jatropha) Acrocomia aculeata (corozo palm) Elaeis guineensis (african palm)	1.800 2.590 4.200 5.550	Erosion reduces. NFO. NFO NFO -

NFO=non food oil.

Some oily ones have advantages because they are leguminous (fix nitrogen), or in dry land they even have good development, or in slope zones they erosion reduce, or they are possible to be cultivated in marginal soils, or like secondary advantage in edges, fallows and retired zones (non food crops).

2.3.2 Agroclimate and soils in Huelva province

The climate and soils classification is determined becomes according to the temperature and rain. This climate system characterizes according to the crops that can be developed. This means according to winter and summer necessities, that is to say, resistance to frosts and drought. This allows define a zone, using indicating cultures, whose exigencies are known and they are satisfied in her. It considers that the fundamental characteristics climates that affect the development of the cultures are two: the thermal regime in its two slopes, winter and summer type, and the humidity regime.
According to the thermal regime, the Huelva province is divided in two zones: I and II (Table 2), and combining its humidity regime (Table 3), the province are subdivided in 5 agroclimates zones: Zone I = 1) **Av, g; ME**, 2) **Av, g; Me** y 3) **Ci, g; Me**, and Zone II = 4) **Ci, G; ME** y 5) **Ci, G ; Me** (Fig. 1).

Table 2.- Termal regime in Huelva province.

	THERMAL REGIME												
	COLD PERIOD								WARM PERIOD				
	Tm (ºC)	tmf (ºC)	ti (ºC)	Duration	Var. NOV	Var. DEC	Var. MAR	Var. ABR	tmc (ºC)	Tc (ºC)	Duration	Var. JUN	Var. SEP
I	15 to 1[illegible]	6 to 13	2 to 7	3 to 4 month	0/10 to 7/10	2/10 to 10/10	1/10 to 10/10	1/10 to 9/10	23 to [illegible]	31 to [illegible]	2 to 3 month	1/10 to 4/10	3/10 to 6/10
II	16 to 19	8 to 12	4 to 7	3 to 4 month	[illegible]/10 to 6/10	3/10 to 8/10	3/10 to 8/10	[illegible] to 4/10	24 to 28	32 to [illegible]	2 to 4 month	2/10 to 9/10	3/10 to 6/10

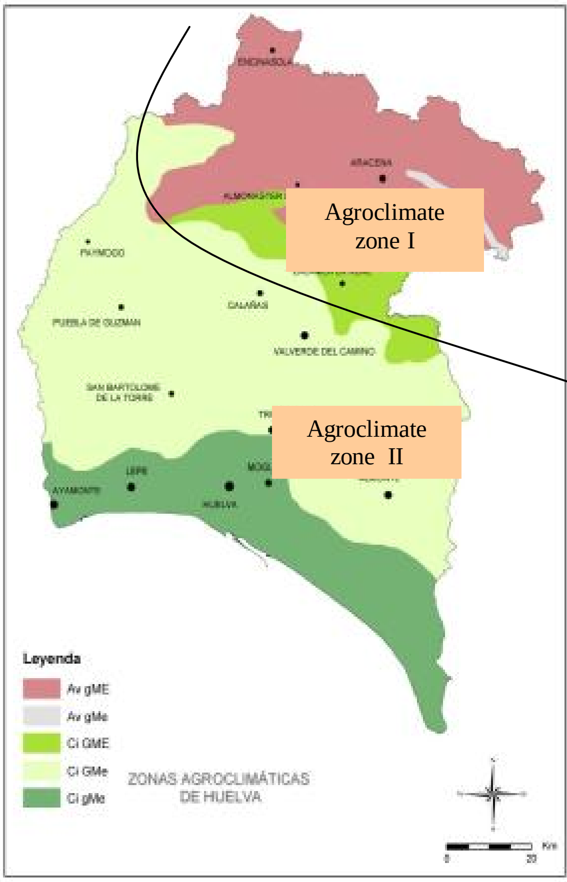
Being: **'Tm'=** annual average temperature; **'tmf'=** average temperature coldest month; **'ti'=** average minimum temperature coldest month; **'tmc'=** average temperature warmest month; **'Tc'=** average maximum temperature warmest month.

Table 3.- Humidity regime and agroclimate classification in Huelva province.

	HUMIDITY REGIME					CULTIVATED VEGETATION						
	P Annual (mm)	ETP Annual (mm)	DRY PERIOD			CLASSIFICATION					TURC INDICE	
			Duration	Var. JUN	Var. SEP	Win-ter	Sum-mer	Therm Reg.	Hum. Reg.	Climate type	Dry land	Irriga-ted
I	500 to 1100	700 to 1000	3 to 5 months	0 to 100%	60 to 100%	Av or Ci	g	CO/TE MA	ME or Me	**Medit. Coast**	15 to 20	45 to 60
II	600 to 1100	800 to 1000	3 to 5 months	20 to 90%	60 to 100%	Ci	G	SU	ME or Me	**Medit. Subtrop.**	15 to 25	50 to 60

Being: Winter types: '**Av**' = Warm oats, '**Ci**' = Citrus; Summer types: '**g**' = Less warm cotton, '**G**' = Warmer cotton; Humidity regimes: 'ME' = Humidity Mediterranean and 'Me'= Dry Mediterranean; Turc indice establishes the territory productive potential to compare it between different zones.

In table 4, the crops with better valuation oily yield is seen, based on its adaptation to the agroclimates zones in Huelva province.



Agroclimate map of Huelva province

Table 4.- Oily crops agroclimates valuación in Huelva province

ZONES	Zone I			Zone II	
SUBZONES	**Av, g; ME**	**Av, g; Me**	**Ci, G; Me**	**Ci, G; Me**	**Ci, g; Me**
Soybean	1,p,r	1,p,r	1,p,r	1,p,sr	1,p,r
Sunflower	2,p,sr	2,p,sr	2,p,sr	2,p,sr	2,p,sr
Rape	2,i,s	2,i,s	2,i,s	2,i,s	2,i,s
Corozo palme	0	0	0	0	0
African palme	0	0	0	0	0
Peanut	2,p,sr	2,p,sr	2,p,sr	2,p,sr	2,p,sr
Ricinus	0	0	0	1,h,io,r	1,h,io,r
Jatropha	1,h,sr	1,h,sr	1,h,sr	1,h,sr	1,h,sr
Safflower	2,o,sr	2,o,sr	2,o,sr	2,o,sr	2,o,sr
Argania	2,sr	2,sr	2,sr	2,s	2,s
Sesame	2,v,sr	2,v,sr	2,v,sr	2,v,sr	2,v,sr
Flax	2,p,sr	2,p,r	2,op,r	2,op,sr	2,op,r

Being: **2** = Verifies crops requirements; **1** = Verifies crops requirements but with limitations; **0** = Is not fulfilled crops requirements; **p** = Spring sowing; **v** = Summer sowing; **o** = Autum sowing; **i** = Winter sowing; **s** = Dry land; **r** = Irrigated land; **h** = Frosts free zone; **d** = Temperatures > 38ºC, minor yield; **u** = If minimum temperature average warmest month is > 20ºC, then 1.

According table 4, the species that better would adapt to Huelva province climate would be: **sunflower, rape, peanut, safflower, argania, sesame and flax.**

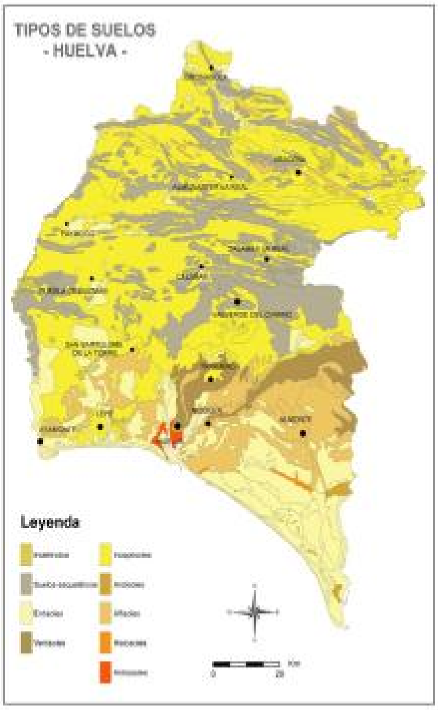


Fig. 2. Soils type in Huelva province

Fig. 3. Soils zones according to agrarian potentiality

According to soils study (fig 2), the Huelva province is divided in two large zones (fig 3):

- Zone 1: generally acid and little deep soils, mountain soils with elevated rocky and much slope locations. These soils are few appropriate for extensive oily crops.
- Zone 2: generally calcareous and deep soils, mechanizable, with sandy and saline located zones. They are agricultural soils. The arable extensive crops have good yields. The oily arable crops adapt without problems, for example sunflower, rape, peanut, safflower, argania, sesame and flax.

2.3.3 Oily crops and available energy crops areas

In the previous decade, in the Huelva province the sunflower (most located in dry land) has been the more important oily crops according to surface culture, followed by nape and the oily flax, and remote soybean and safflower. The yields obtained with this crop have been very upper to the others, including rape, as much in dry land as in irrigated land. In those years the production of these crops was distributed between the domestic consumption and to the obtaining of cakes and flour for livestock, reason why were not considered 'energy crops'.

The advantage sunflower is its easy culture and good adaptation to abundance variety dry land. Recent relatively and less well-known in Huelva, the rape has but necessity of nitrogen, but sensitivity to plagues and less adaptation to low inputs crops system, although its yield is slightly upper to the sunflower (Table 5). Nevertheless, in Huelva province the sunflower yields always have been upper to the rape. The average data sunflower indicate 1.095 and 2.460 Kg/Ha in dry land and irrigated land, respectively, with 33.165 Tn seed production and 9.831 Tn oil (29,6 % industrial yield). In those dates, the nape yield have been 625 and 1.150 Kg/Ha in dry land and irrigated land, respectively, with 1.314 Tn seed production and 328 Tn oil (24,9 % industrial yield).

Table 5.- Test results with sunflower (2005) and nape (2006-07). 'Red Andaluza de Experimentación Agraria' (RAEA).

		Production (Kg/Ha)	Oil yield (%)	Oil (Kg/Ha)
Sunflower	Dry land	839	44,0	374
	Irrigated land	2.052	48,0	999
Rape	Dry land	2.190	46,0	1.026
	Irrigated land	2.377	46,5	1.119

Two hypotheses can explain the smaller yields nape in Huelva province: a) the sunflower is cultivated in the best edafic-climatic zones, whereas the nape is located in less productive and marginal zones (f.e. zones with high sand proportion); and b) the nape has been handled by error as a rustic culture, similar to the sunflower, and for that reason has not been reached its maximum potential productive. In fact they have been used cereals combine harvester with mall pillows no appropriate or not fit for the nape harvesting, which has given rise to important losses of the harvested grain. Probably this second hypothesis has influenced more than first in the low yields of this crops.

2.3.4 Present surface with oily cultures and areas available for power cultures

According to agroclimate map (fig 1) and the edafic zones (fig 3), the agrarian regions of Huelva province (fig 4) are grouped in two large zones: a) 'Sierra', 'Andévalo-Occidental' and 'Andévalo-Oriental' regions with limitations for oily culture; and b) 'Costa', 'Condado-Campiña' and 'Condado-Litoral' regions with good oily crops development. In this second zone is where traditionally it is most herbaceous crops (group that includes the oily crops), as much in dry land as in irrigated land and it is where the available areas for energy crops are located. The present surface with extensive herbaceous crops (wheat, barley, sunflower, etc.) he is bigger than 53.000 ha. in dry land and 2.000 ha. in irrigated soils (fig 5).

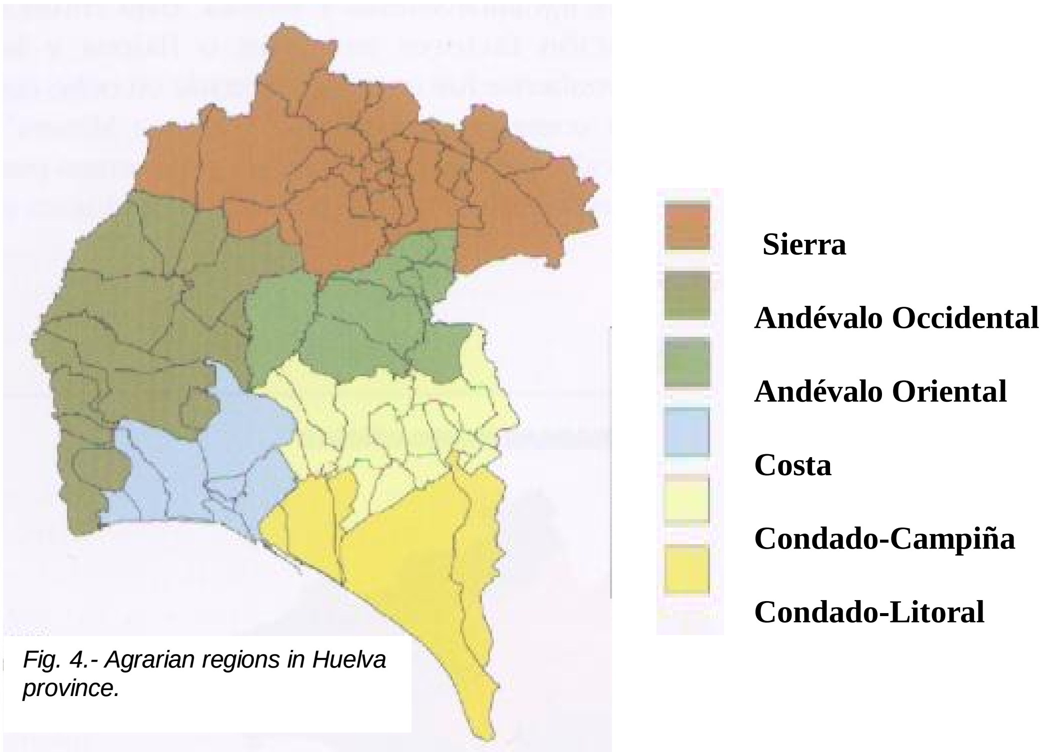


Fig. 4.- Agrarian regions in Huelva province.

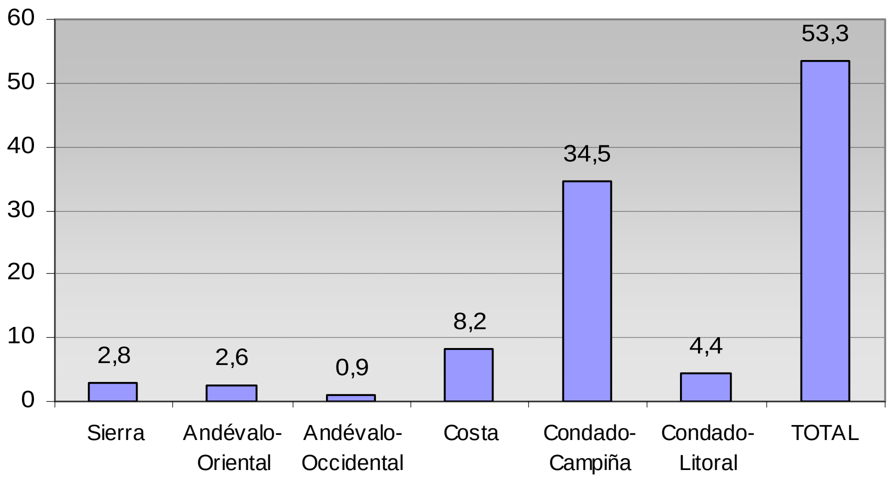


Fig. 5.- Surface (thousand hectareas) with herbaceous extensive crops in the agricultural regions in Huelva province.

In the last years, all the surface with oily is cultivated with sunflower. This crop extends mainly by 'Condado-campiña, ' Costa' and 'Condado-litoral' regions, as much in dry land as in irrigated land. Now there is not even no nape, that when finalizing the last decade reached the 1.000 ha. almost (dry land and irrigated land), probably by reasons previously indicated. In recent years (2004, 2005 and 2006) the data indicate that sunflower surface in dry land is 15.444 ha. (± 2,175) (fig 6) and in irrigated land is 743 ha. (± 293) (fig 7) (Table 6). These numbers indicate that 4,5 % single sunflower surface is in the best productive conditions (irrigable land).

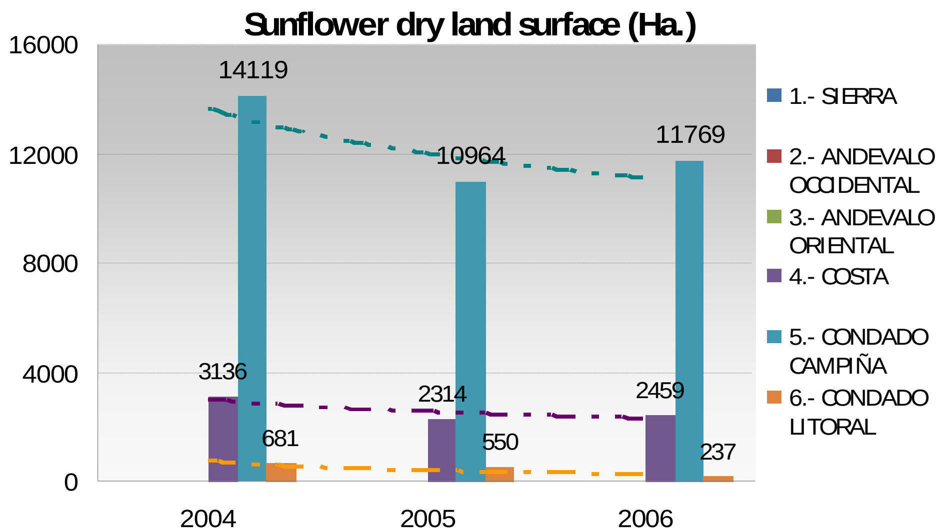


Fig. 6.- Annual surface by regions whith sunflower crops in dry land in the Huelva province. In the three regions where there is much sunflower it observes the tendency to diminish the cultivated surface.

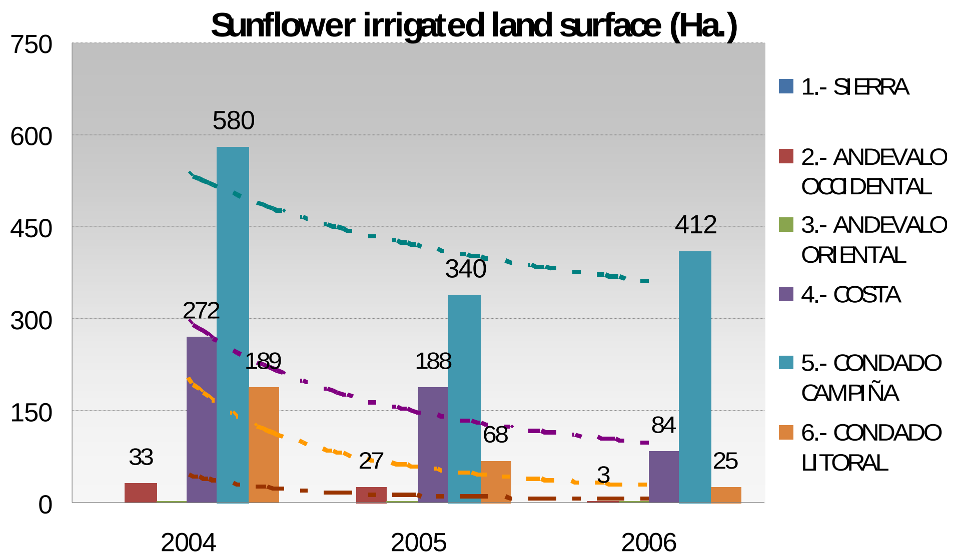


Fig. 7.- Annual surface by regions whith sunflower crops in irrigated land in the Huelva province. A significant surface reduction in all the regions with sunflower crop is observed

Table 6.- Surface (Ha.) sunflower crops surface in Huelva province.

Regions	2004		2005		2006	
	Dry land	**Irrigated land**	**Dry land**	**Irrigated land**	**Dry land**	**Irrigated land**
Sierra	0	0	0	0	0	0
Andévalo Occidental	0	33	0	25	0	3
Andévalo Oriental	1	3	1	3	1	2
Costa	3.136	272	2.314	188	2.459	84
Condado Campiña	14.119	580	10.964	340	11.769	412
Condado Litoral	681	189	550	68	237	25
TOTAL	17.937	1.077	13.829	626	14.466	626

The 'Herbaceous Crops', include cereals and oily and others crops, are the crops classic in extensive regime. The cereals and the oily crops ones are very similar in their agrocharacteristics and culture technical, therefore any farmer can easily crops change. In fact, the normal thing is to make rotations among them, p.e. 3-4 years sunflower and the following year a cereal, or any other combination. The previous thing means that there is a competition by the same surface between both crops groups.

Since there are no technical impediments by the election between crops, the one is the price of market that farmer election decides. With respect to these prices, there is cereals boom caused by the demand increase and the smaller reserves are every time. Thus, although Spain is traditionally cereals deficit, is the international market, with the India and Chine imports, and the biofuels industry (bioethanol made with maize and wheat) although the amount is small, the one that has elevated too much the cereals demand. With this situation, the European Commission considers and 6 % cereals prices increase until year 2020. This cereals price maintained increase has not been detected in the oily ones, which comes to mean, in the short and mid term, an cereals surface increase in damage of the surface oily.

This already is detecting in the Huelva province, has disappeared the nape crop, since it has commented previously and the reduction of avauilable energy crops areas available is observed, thus in sunflower the tendency is to reduce the annual surface around 4 % in dry land and 37 % in irrigated land. In the 2007 numbers advance, the surface sunflower in Huelva province for that year it is of 13.082,66 ha. Single they have been contracted as energy crop 26,51 has. with sunflower in 'Gibraleon' municipality and 2,03 has. whict nape in ' Escacena del Campo' municipality. Therefore, around 0,2 % of the surface total with oily crops really it is dedicated to energy crops, a very small.

2.3.5 Estimation of present and potential the oil that generates the oily cultures in the Huelva province

As one has commented, the sunflower is actually the only energy oily crops in Huelva province. Its production oscillates annually, mainly by the climatology, although one is in the 700-1,500 in dry land and 1.700-3.500 Kg/Ha. in irrigated land rank, with 1.095 Kg/Ha in dry land and 2.460 Kg/Ha average productions in irrigated land. With these data the annual average production in Huelva province is 16.911 Tn (±2.381) in dry land and 1.827 Tn (± 720) in irrigated land. Considering 24,9 % of industrial yield, the present oil production is around 4.665 Tn (± 772).

The continued elevation of cereals price indirectly implies a diminution of the surface destined to the sunflower culture, by trasvase of this one towards the cereal production. In the Huelva province, this diminution has been confirmed in dry land and, mainly, irrigated land. Consequently, the next oil estimations productions are going to follow the same trajectory (fig 8-10). If the considered annual date sunflower surface (dry and irrigable land around 16.000 ha) (2007 fig 8) and advance surface date for 2007 are 13.082,66 ha., the forecats have been slightly optimistic. This indicates that the true sunflower surface reduction has been slightly high to the estimations. Probably, the increase of cereal price and the insufficiency of the present aids to the energy crops (45 euros/ha), have lead to this situation.

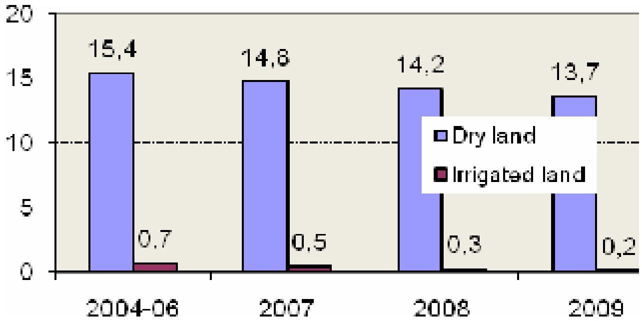


Fig. 8.- Recent surface (thousands Hectareas; years 2004, 05 and 06) and forecast (years 2007, 08 and 09) sunflower culture in Huelva province. The dry land surface is higher than irrigated land. Next years in both land the foreseeable surface diminishes.

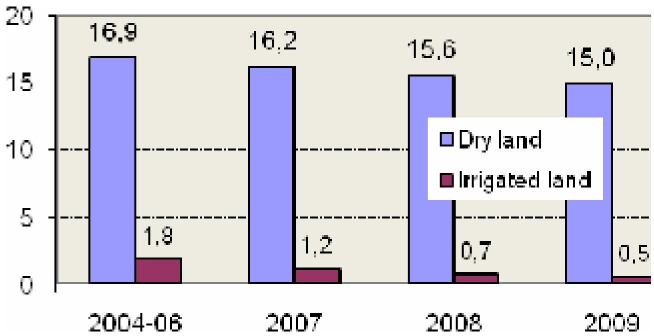


Fig. 9.- Recent seed production(thousands Tn; years 2004, 05 and 06) and forecast (years 2007, 08 and 09) sunflower culture in Huelva province. The production in dry land is much high that in irrigated land. Next years in both land the foreseeable seed production diminishes.

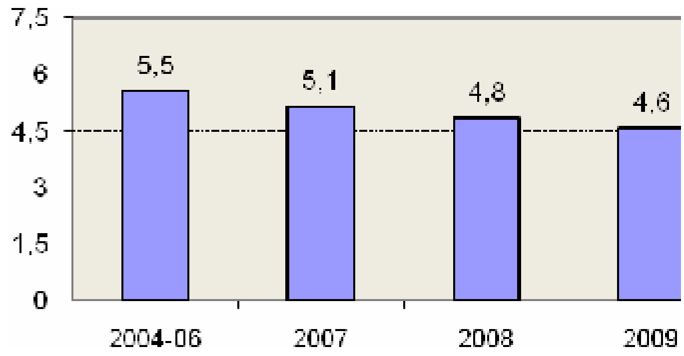


Fig. 10.- Recent oil production oil (thousands Tn; years 2004, 05 and 06) and forecast (year 2007, 2008 and 2009) sunflower culture in Huelva province. Next years the foreseeable oil production diminishes.

2.3.6 Conclusions

Summary, the most important conclusions of energy crops cultures in Huelva province, are the following ones:

- The energy crops more adapted by its high productions and adaptation to climate and soils of Huelva province are nape and mainly sunflower. If the agronomic handling colza in Huelva province improves will be able to equal and to advance the sunflower yields.

- By climate, topography and soils, the agricultural regions 'Condado Campiña', 'Costa' and 'Condado Litoral' are the best ones to cultivate sunflower and colza. In these zones the mean efficiencies are medium in dry land (1.095 Kg/Ha) and higher in irrigated land (2.460 Kg/Ha).

- Nowadays, the only oily culture in Huelva province is the sunflower. The surfaces cultivated recently indicate around 15.500 Ha in dry land and 750 Ha in irrigated land, with a harvest of 17.000 Tn seed in dry land and 1.800 Tn seed in irrigated land and 4.700 Tn oil production.

- The cereals and the oily crops compete by the same surface. The maintained increase on cereals demand has increased its price and elevated its culture surface, with reduction of oily cultures surface. Thus, in Huelva province the anuually sunflower surface has been considered that diminishes 4 % in dry land and 37 % in irrigated land.

- In the data advance of 2007, the 0,2 % of oily cultures surface have been contracted as energy crops, it means that the oil volume that is used in Huelva province to obtain biodiesel is very small.

- The present support measures of the UE to energy crops, for the agronomic, climate and edafic conditions in Huelva province, they have not been able to increase the surface cultivated with these crops.

2.3.7 Strategies to be proposed

Huelva province is characterized to have climate and soils adapted for generalized oily crops. Nevertheless now there is a strong backward movement of the sunflower surface and other cultures have even disappeared (f.e. nape, flax, soybean and safflower). In addition the amount oil of energy crops that is used to produce biodiesel is null practically.

In order to improve this scene several strategies set out:

a) To viability adaptation study to the climate and soils in Huelva province for crops with with high oil productions (f.e. jatropha, african and corozo palm), as well as the best culture techniques and environment take care. For as much, it is recommended to finance public centres with knowledge and capacity of investigation in oily crops.

b) To improve and to optimize the sunflower and nape culture techniques and to foment the culture of varieties with high performance in dry land and adapted to the climate and soils of Huelva province. Courses, machinery demonstrations and visits to model farms are essential and to increase the electronic information making pages in internet with updated information of oily energy crops.

c) To make possible the energy crops in retired cultures territories (non food).

d) To stimulate the creation of a association provincial of energy crops.

e) To build oil refinery in the Huelva province near the seed productions zones. This refinery must to grind the grain of any oily one. The companies that use oil to do biodiesel in Huelva province must be contributor in this refinery.

2.4. POMURJE (SLOVENIA)

2.4.1 Sunflower

The total area cultivated under the sunflower represents only 5% of the oil-rape, which is caused by the very high water and nutrient consumption of that particular plant.

Table 2: Cultivated sunflower area (ha) in Pomurje during last seasons

YEAR	UNIRRIGATED LAND	TOTAL(ha)
2000	24	24
2001	20	20
2002	25	25
2003	107	107

2004	56	56
2005	40	40
2006	156	156
2007	246	246

Since, the sunflower areas are not irrigated as well, the annual average yield is very small lying beyond 1,5 t/ha.

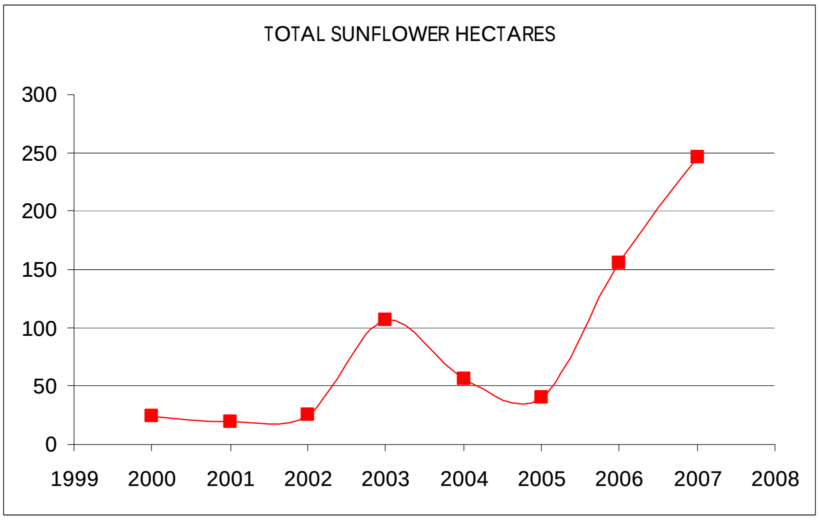


Diagram 2: Increase of cultivated sunflower area in Pomurje region during last seasons

2.4.2 Rape

Regarding the vegetation and climatic conditions in Pomurje region (Slovenia), the autumn oil-rape is the most appropriate energy plant as a raw material for biodiesel production. Although, in the mid of 1970 the oil-rape cultivation already reached almost 5000 ha, a new wave of interest for this particular plant has been stimulated whenever introduced as a raw material for bio-diesel. As seen in the table 1 the areas under the oil-rape has been constantly increased from 122 ha in 2000 to 5417 ha in 2007.

Table 1: Cultivated oil rape area (ha) in Pomurje during last seasons

YEAR	UNIRRIGATED LAND	TOTAL(ha)
2000	122	122
2001	398	398
2002	2433	2433
2003	2705	2705
2004	1945	1945
2005	2260	2260
2006	2809	2809
2007	5417	5417

However, the average yield does not exceed 2,9 t/ha in any year, since practically all the oil rape is cultivated on the unirrigated areas, which suffered huge water shortage in some years.

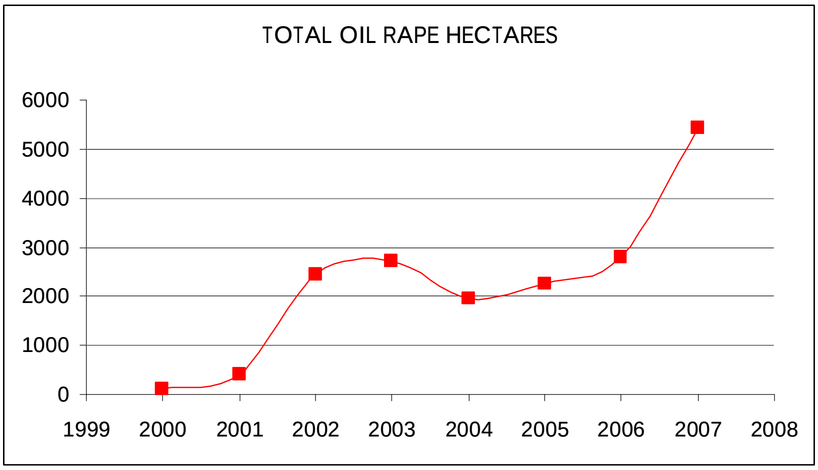


Diagram 1: Increase of cultivated oil-rape area in Pomurje region during last seasons

2.4.3 Conclusions

The autumn oil-rape was well known oil plant in Pomurje already in the past century, however due to the low prices of vegetal oil it has been practically disappeared from the fields. A new discovery and introduction of this plant fitted together with the biodiesel production.

Production level

Oil-rape has a great significance from the point of permanent preserving of the ground fertility and for balancing rotation of otherwise intensely narrowed of field crops. Oil-rape perfectly matches into a rotation of crops, secondly it protects the ground from erosion during the wintertime and also is a good early crop for stubble grains, feeding and leguminous plants. It has a most positive influence on ground, as it forms a densely spread root system in the cultivated layer and a good deal of humus with its disintegration, that is why it is reasonable to rejoin it into the rotation of crops in extremely large extent.

However, there is insufficient agricultural surface for the raw material production in Pomurje, because of the smallness of Slovenia, which causes on local, as well as on national level the permanent problem of lack of agricultural land, appropriated for oil-rape cultivation. Another problem lies in the oil-rape itself, because it can not be sowed every year at the same surface like maize, but it needs a rotation of crops (at least every third or forth year).

Furthermore, reliability and durability of raw material supply for energy purposes is uncertain. Looking forward to a long-term period, the reliability of raw materials production on local level is uncertain as there is a constant lack of agricultural surface for the energy plants production and the instability of the prices in the agriculture, caused by the high increase of other field crops prices.

In 2006 the largest purchaser of grains in region Panvita Group gave an offer to all oil-rape producers for repurchasing of crop by market prices based on the contracts concluded before sowing. Thus, the producers have the assured purchase of crop, which is at the same time with rather high state subventions a good stimulation for them. However, the particular producer should assure the minimum amount of oil-rape crop, which amounts this year to 1.920 kg. That minimum amount is defined in the frame of ordinances about the subsiding of energy plants production. However, in the case, the producer does not assure that minimum amount required; the payment of the subsiding of energy plants production will be frozen. Furthermore, the state will simultaneously freeze the subsiding of the entire rest crop, until he explains the reason for the smaller quantitative crop. That negatively influences on decisions for production among the producers. However, the producers in Pomurje have not any problem regarding the minimum assure of crop during last two years, because of the comfort weather conditions. Those problems were met last years, during the dry periods in Pomurje.

In 2005 the use of biofuels in fuels for motor vehicles driven in traffic started to grow in Slovenia, however the trend of increasing has stopped because of technical troubles at use of that fuel and insecure supply with those fuels. The reliability of supply with biofuels has stabilized and we are expecting that the quantity of biofuels in Slovenia region during the period of 2007-2010 will slowly increase.

The quality of biofuel should fulfill the requirements of SIST EN 14214 standard, which influences that the smaller producers of biofuel with their pilot manufacture can not buy such devices for chemical analyis and are therefore without quality control of biodiesel.

The participants of the expert panel meeting warned also against the lack of interest for the raw material production due to the insufficient activities for increasing both the raw material base for biodiesel production as well as organised collecting of waste oils (public utilities) and animal fat (slaughterhouses).

Particular question was given to the storehouse capacities for the raw materials in case of higher yields and areas as it was in 2007, when the oil-rape was sowed at the most surfaces ever, and the weather conditions influenced favorably the harvest quantity.

In the near future a particular increase of oil-rape areas is going to be as a substitution for the former sugar beat production, which let to adaptation of agricultural mechanization (sowing machines), and the use different pesticides and fertilizers.

For increasing the oil-rape production in future the contractual agreements between local authorities, distributors and larger consumers of biodiesel should be signed, which would rise the production and consecutively consumption of biodiesel.

The first attempt for bigger production was given by Panvita Groups, which offer to all oil-rape producers for repurchasing of crop by market prices based on the contracts concluded before sowing. Thus, the producers would have the assured purchase of crop and the state subventions at the same time. However, the producers, who sign that agreement, should assure the minimum amount of oil-rape crop, which amounts this year to 1.920 kg, which was defined in the frame of ordinances about the subsiding of energy plants production.

Another problem is a warranty payment, as an assurance, that oil-rape will be actually produced. The regulated amount of warranty, which at the Agency RS for agricultural markets and development of countryside (for oil-rape areas in fallow ground 250 € and 65 € to hectare for the surfaces, where asserts the energy supplement, so from the active rotation of crops) should be put as an assurance, that the repurchased oil-rape will be really sold out as a raw material for biofuel, strongly burdens the producers or, in this case, the purchaser. From this point the Panvita Group pay for the warranty of oil-rape cultivation on 1.500 ha approximately 375.000 € for the period of ten months, which for sure do not stimulate the oil-rape production.

Under the experts opinion the oil-rape production is suitable for larger farms, which own over 17.45 ha of cultivated surfaces. For those farms the fallow ground is obligatory from the year 2004. The areas in obligatory fallow ground can therefore be used for reproduction of raw materials into biofuels or other goods not assigned for human being or animals nutrition. Thus, many farmers decide to grow oil-rape at cultivated surfaced intended for obligatory fallow ground. However, it is impossible to assign a subsidy for energy plants instead of surfaces in fallow ground, as the producers are legitimated subvention, regulated for fallow ground.

Subventions for oil-rape production and other energy plants
Provisions of agricultural policy stimulate the production of appropriate field crops for biofuel production. The oil-rape producers, in accordance with the immediate payments ordinance for balancing expenses of production, have a right to immediate payment (subvention) from the state in the amount of 332 €/ha. Besides that, the producers have a right to supplement finance stimulation in the amount of 45 €/ha. That supplement finance stimulation includes also other energy plants, such as soya, sunflower and sorghum, the production of which in our place in comparison with oil-rape is less technological accomplished.

Other stimulations (from finance view)
The Panvita Group assures to permanent contract customers, who contractually produce also some other kinds of field crops, a seed and mineral nutrition payment delay for oil-rape production for the time from sowing till harvest, when the final settlement is ready.

At the end, there are only favorable bank loans left, for the energy plants producers, in the region.

2.4.4 Strategies to be proposed

The precise analysis of current situation and possible crops for biodiesel productions in Pomurje region involve the starting point for creating strategies in increasing the cultivation of energy crops.
It is very important to **connect all parts of the biofuel chain** into common strategy begging from producers of raw materials, purchaser of the oil seed, biofuels producers, distribution and the users of biodiesel.

Since in the Pomurje region there is a constant lack of arable land and farmers are not willing to increase the production of oil-rape significantly, a strong attention and contribution should be focused **on the farmers' education**. On such courses not only the guidelines for growing the plant should be precisely presented, but also all importance of oil-rape for the crop rotation, soil erosion protection and soil nutrition increasing must be presented from all view of aspects. However, the constant education is not important only for the farmers, but also for all other users of the biodiesel, especially whenever teaching the young generation of the importance of CO2 reduction with the increasing of biofuels consumption and the fat waste conservation in order to produce the new biodiesel components.

The Pomurje has still a rather big potential for oil plant production, which could be also enforced by omitting the warranty payment of oil-rape seed purchasers, which can stimulate also smaller biodiesel producer to increase their production and build the petrol stations, which are at the moment only two in the whole region. With such strategy the **medium sized facilities linked directly to the grain production and self-consumption**, as prototype of biodiesel producer would be promoted.

2.5. ABRUZZO (ITALY)

In Italy renewable energetic sources represents an extraordinary opportunity to increase the competitively of the economic system, especially through the lower dependency from the importation of conventional sources. Moreover, it is an opportunity of economic development and occupational through research and innovation. With this regard the Abruzzo region, as many other Italian regions, has oriented its attention to the use and diffusion of renewable energy.

The use of vegetable oils as fuel for endothermic engines is a very interesting application for the development of alternative renewable energy sources, following the Kyoto protocol and the recent Italian and European legislation about renewable fonts. The use of fuels derived from vegetable oils represents a potential opportunity to meet EU Commission guidelines promoting renewable energy utilization. This is particularly true for Mediterranean countries where farmers are well familiarized with oil crops. Liquid biofuels are the only direct substitute for oil in transport and, for this reason, have high political priority. Directive 2003/30/CE of the European Parliament and the Council is aimed at promoting the use of renewable fuels in order to replace diesel oil and gasoline (petrol) for transportation, with the goal of diversifying the European energy supply, reducing the reliance on imported energy, contributing to the reduction of greenhouse gases emissions and climate changes (Kyoto Protocol targets) and enforcing the environmental safety.

The *Abruzzo* Region borders at East with the Adriatic coastal hilly belt, and at West with the mountainous chain *Abruzzo's* Apennine. The surface area covers 1,079,431 ha, and represents the 3.6% of the national territory. Mountainous landscape covers 702,792 ha (65%), from which 376,621 ha is located on hills (16% internally and 19% along the coast), while plains are absent.
Abruzzo's landscape is characterised by extensive mountain massifs from west to east, where lies Abruzzo's other identity: the Adriatic Coast.
The massifs begin at north, with the Mountain chain *Monti della Laga* and the group of the *Gran Sasso*; going towards Southeast there is the *Maiella,* followed by the *Meta.* In the west stand the *Ernici* and *Simbruini* Mounts. The mountainous and hilly territory boasts three main basins: the *Aquilana* basin that runs through the *Aterno* river, the *Sulmona* and *Fucino*. The roughness geography of the territory influenced the location of the population along the coastal hills (54%) while only 30% reside in the mountainous area. The vegetative soil cover is distributed between agricultural and forest areas, 42.5% and 36.3% respectively. The regional agricultural land is equal to 492,022 ha (67% of the Territorial Land) and is divided as follows: 43.1% cultivated land, 37.2% permanent grasslands and pasture, 18.8% tree cultures. The *Abruzzo* territory includes 300,217 ha, 27% of the total regional soil surface, dedicated to parks and natural reserves. Three-quarters (232,560 ha) belong to national parks: the National Park of *Abruzzo*, the National Park of Mount *Gran Sasso* – Mount *Laga* and the National Park of the *Maiella*.

The most important land use is for cereal crops, which in the past made up the majority of the total cultivated area. Vineyards and olive make up for the most part of the tree crops. There is a remarkable differentiation in land use among the four provinces (L'Aquila, Teramo, Pescara and Chieti). The agricultural land for annual crops represents a surface of 182,876.7 ha (17% of total area). In the table it is reported the agricultural land for each province.

Province	Agricultural land for annual crops (ha)
L'Aquila	42,842.64
Teramo	57,812.75
Pescara	32,790.43
Chieti	49,430.88
Abruzzo Region	182,876.70

In the last 20 years the range of annual average rainfall has been between 500 and 1500 mm/year.

2.5.1 Crops for Bio-Diesel Chain

In the Abruzzo Region the cultivation of energy crops for the biodiesel chain has not been implemented yet. The potentiality of cultivation in rainfed conditions is estimated to be around the 20% of total agricultural land for annual crops: about 35,000 hectares. Currently, the cultivation of industrial crops with possible shift to energy crops, are Sunflower, Corn and Soybean. Canola is not cultivated. In the following table is reported the main information regarding the crops cultivated.

	SUNFLOWER	CANOLA	OTHERS (CORN-SOYBEAN)
SURFACE, ha	4,718	3	7,704
SEEDING TIME	February	October - November	April
HARVEST TIME	August - September	February	July - August
TILLAGE PRACTICE	Ploughing - harrowing	Ploughing - harrowing	Ploughing - harrowing
FERTILIZZATION (N - P - K) kg/ha	80 - 120 -70	150 - 115 - 80	120 - 80 -70
WEED CONTROL (l/ha or kg/ha)	Oxifluorfen 0.8 – 1 Oxadiazon 1.5 s-Metolachlor 1.25 – 1.5	Metazaclor 1.80 - 2,5	Terbutilazina 1.5 Dimetenamide 1.5 Pendimetalin 1.5 – 2
POTENTIAL YIELD, t/ha	1.94	0.7	8.46 (CORN) 3.08 (SOYBEAN)
OTHER PRACTICES	Crop residual on surface management	_	Crop residual on surface management (maize)

In this context, Sunflower represents the main potential energy crop for the Abruzzo region, due to the suitability to be cultivated on rainfed conditions and for its introduction in the rationale farming systems model.

In Italy 55,000 ha of sunflower was grown commercially for biodiesel production with an average yield of 1.7-2.4 odt/ha. Sunflower is one of the most adapted crops to dry conditions typical of Mediterranean environments. The oleic acid content in sunflower oil seems to be a suitable character for biofuel production with regard to fuel oxidative stability. For the same reason, the high oleic varieties are considered particularly promising.

As other herbaceous field crops for renewable energy, the sunflower response to sustainable practice can vary depending on pedo-climatic conditions, cultivation techniques (time of sowing and period of weed control) and the extent and quality of changes, at short and long term, induced by these same techniques on the agro-ecosystem.

In the case of sunflower, it is possible to apply the conservative practices (as minimum tillage and no-tillage), but it should be considered the crop peculiarities in order to improve the eventually positive interactions between them and the new techniques adopted.

Sunflower completes its own biologic cycle in relatively short time with respect to other crops as maize and sorghum. Thanks to its lower thermal needs for germination, it is possible to anticipate seeding (half of March) with a consequent earlier harvesting (half of September). As consequence, sunflower flowering happens in June, a period when temperatures are not yet particularly high and there is the possibility of precipitations. Therefore, the stage of sunflower could allow a minor risk of hydraulic stress respect to other renewal crops.

During the selection of the agronomic techniques to be adopted, we have to consider the sunflower strong and deep roots which focus on a taproot able to grow beyond 1 m depth. This powerful root system, guarantee the sunflower a full use of water and nutritional resources even in clay soils, although the crop shows a little ability to penetrate in layers of compact soil that may encounter along the soil profile due to natural causes or as a consequence of tillage management (Maerthens and Bosc, 1981).

The excellent colonizing ability of root allows the sunflower to use, in a profitably way, the nitrogen in soil thus resulting in low efficiency response to nitrogen fertilization compared with other renewal species. With this regard, the availability of nitrogen to the crop would be particularly important in raise phase (that normally happens in May) to support the rapid development of the crop. At this phase, which corresponds at 4 – 6 leaves stage, the availability of nitrogen in the soil would increase the amount of fertile flowers and the potential yield of the crop (Merrien, 1986).

Before introducing the interaction between the conservative agriculture techniques and the sunflower characteristics, it is important to make a brief summary on the role of the sunflower as renewal crop in Italy.
Because of its adaptability to sub-optimal pedo-climatic conditions (heavy soils, no irrigation, no flat land) sunflower is widespread in central Italy (hilly regions such as Abruzzo). In these regions the sunflower cultivation represents the significant percentage of total sunflower cultivation in Italy.

The productivity of the sunflower is strictly linked to the soil fertility and the water availability (groundwater, spring/summer rainfall). In fact, although sunflower is considered a drought–resistant crop, its water seasonal consumption is similar to those crops that need a relevant amount of water. Therefore the increase of the water availability has a decisively influence on the productivity of sunflower 3 t/ha on the plains of internal and hilly area in Abruzzo Region.
The choice of the agronomic practices has been always directed to improve the soil water retention in order to prevent crop water stress. During the past centuries, deep tillage has been considered as the best practice to conserve water in soil during the rainy months. On the other hand, it has been shown that deep tillage can impact negatively on the physic characteristics of soils. The loss of structure stability can produce, over time, a progressive

compaction of soils with the consequence of reduced water infiltration. Moreover, the loss of structure can contribute to increasing the run-off risk.

An adequate soil water infiltration of rainfall could be obtained using alternative techniques to the conventional ploughing, i.e. minimum tillage and no-tillage. Implementing the conservative techniques, water infiltration can be enhanced thanks to the reduction of the run-off due to crop residues on soil surface.

Regarding the reduction of soil moisture evaporation, the minimum tillage techniques have shown to maintain for longer period the soil moisture (especially on superficial layers) thanks to the vegetal mulching, natural or artificial, on the soil and the higher percentage of micropores.

Therefore, the conservation agriculture can have a positive effect on sunflower production in two ways:

- Giving to this crop a better capacity for using the water resource
- Limiting the environmental impact of its cultivation in hilly environment through the reduction of the erosive phenomenon.

2.5.2 Guideline for the implementation

The application of conservative techniques on sunflower must be accurately analyzed, in relation to the agro-pedo-climatic conditions of the cultivation area and the peculiarity of the oleaginous.

In this analysis we will refer to the “more extreme” conservative technique: the no-tillage, and step by step we can even refer to the technique of minimum tillage.

The application of any tillage technique on the field, should guarantee an efficient hydraulic system. This is particularly important, during the winter and spring, to avoid the water excess in order to permit a quick heating of the superficial soil layers. This is crucial for renewal crops in sod seeding because sod soil temperature is lower than the traditionally tillage soil. In sunflower early seeding, delay crop emergence has the consequence of increasing seed predation by birds. A little delay of the sod seeding period could offer greater guaranty for a quick and uniform emergence of the plant.

In this context, it is fundamental that the sunflower in sod seeding must be preceded by crops that do not cause compaction on the superficial layers of soil. Therefore it would be opportune to prefer species with early summer harvesting at end of June. A bad superficial settlement of the soil in sod seeding represents a risk for the good development of the sunflower under no-tillage cultivation because soil could be affected by superficial water stagnation during the early spring.

The selection of the previous crop is very important because it represents the definition of the “sod system” in term of the quantity of crop residues that can be released on soil surface with harvesting ratio. With this respect, crop residues with high C/N ratio (cereals normally) requires more time to be degraded. The release of crop residues on the soil surface could enhance the eventually allelopathic effect of some species (rye, sorghum, etc.) on the sunflower seed during germination.

The conditions derived from the no-tillage technique on soils favours the development of many biological activities determining a certain risk of parasitism of the seed and/or the plant and the development of fungi diseases. Therefore it is required to ensure the quality of the seed, the nature of the fertilizer and the possibility to use insecticides. To overcome this problem, it could be introduced cover crops into the “sod system” appropriately seeded at the end of the summer. The use of cover crops could:

- reduce the seed predation by birds
- reduce the development of infesting flora during the winter season and spring-summer season
- reduce the soil moisture evaporation during the spring-summer season

Moreover, the presence of a compact vegetal cover until the sunflower sod seeding could improve the state of aggregation of the soil, favoring the formation of an adequate bed-seeding.

2.5.3 Benefits and limits

The benefits of conservation agriculture applied at the sunflower crop, can be measured both in agro-environmental and in production terms.

Due to the great diffusion of the sunflower in the clay soils of the central Italy, the most common tillage technique practiced is represented by the deep or medium ploughing. The first and the simplest conservative technique is represented by the ripping, much appreciated by the farmers because of its good effect on the soil mass (specially on clay soils). The good adaptation of the sunflower production to this technique is shown by the minimum difference of yield comparing this technique with ploughing at a variable depth between 30 – 50 cm.

Results observed in Spain from Murino et al. (1998) showed an increase in term of yield of about 23%, while in Argentina an average yield increase of about 5% and a maximum of 25% using a subsoiler instead of chisel (Botta et al., 2006). Regarding the minimum tillage, in favorable climatic conditions (such as in France), the implementation of this simplified technique has produced a slight increase of the sunflower yield respect to the ploughing conventional tillage technique, both on the clayed soils (3,1 t/ha of grain vs. 3,00) and on sandy soils (3,82 t/ha of grain vs. 3,42) Perny (1993). In Italy the adoption of minimum tillage for sunflower crop has given results, due probably to the frequently use of inappropriate equipments to apply this conservative technique. The research carried out by the Crop Science Department of the University of Perugia (1986-1990) has shown, on heavy soils well structured, an average reduction of the sunflower yield of about 9-13% with respect to the deep ploughing. In three of five years of research, the sunflower yields were not statistically different from those obtained with ploughing. Working in the same environment, a 4 years research (1987-1990) conducted on a flat heavy soil characterized by a scarce presence of “montmorillonite” clay, deep ploughing has shown a reduction of sunflower yields (about 18%) with minimum tillage respect to the deep ploughing. In two years no differences between the two techniques were significantly noticed (Bonari et al., 1996).

Regarding the possibility to seeding the sunflower in a no - tillage soil, currently on account of the few experiences done in Italy, it is difficult to know the response of the oleaginous to this process, strongly depending on the soil and climate conditions. Little research has been done about the phosphor-potassium and organic fertilization issues in no-tillage systems. Generally, when these nutrients are not buried they concentrate on the soil superficial layers (first 10 cm) with a reduction in deeper layers, and consequently a lower availability to the crop. It should be studied the possibility of progressing impoverishment of the sub-superficial layers and the consequent yield reduction of sunflower. According to the information and consideration above mentioned, it is reasonable to consider the possibility of increasing the adoption of the conservative techniques for the sunflower production in Italy. Because of the diffusion of this oleaginous on hilly areas, the adoption of conservative techniques should be considered a valid instrument to limit the water erosion and to enhance the soil moisture conservation.

The reduction of time and fuel use, associated to this techniques, must be considered as a benefit for sunflower production because of the reduction of cost inputs.
It would be advisable to verify in detail the productive response of the crop to the conservative techniques in the Italian environments, characterized by not particularly drought conditions and scarce availability of post-emergency herbicides.
For the application of these conservative techniques on sunflower production, it should be applied a full research of the entire production chain, such as: weed control, seeding modality and crop defense and fertilization.

Corn and Soybean
These crops are limited for its cultivation as energy crops because they request an irrigation supply and the presence of a small fodder industry on the territory.

Canola
Canola could be a potential energy crop for biodiesel chain if the new genotypes adapts to the particular environmental conditions of rainfed hilly area of Abruzzo region. It is necessary to apply a new research program for the evaluation of the adaptability and yield response in joint with new agronomic practices that preserve soil fertility and reduce soil erosion with positive impact on CO_2 balance.

3. GENERAL SUMMARY

In this study the 'PROBÍO' European Project, which is co-financed by the program "Intelligent Energy-Europe" (IEE), focuses on renewable energy based on energy crops, which can reduce CO_2 pollution and decrease the green house effect of gases significantly.

The main aim of the presented comparative study is to analyze and describe the current energy crops situation and its future potential for growing as the raw materials for biodiesel production in the five partner regions Ávila, Burgos, Huelva (Spain), Pomurje (Slovenia), Abruzzo (Italy).

The definition, classification, geographical and seasonal crop distribution clearly shows the great variety of species and varieties grown in particular regions, which include Linun usitatissimun (flax), Carthamus tinctorius (safflower), Glicine max (soybean), Helianthus annuus (sunflower), Brassica napus (rape). However, according to the specific regional weather and geographical conditions, in 2006 ***the sunflower represents the most important energy plant in four regions Ávila (7.624 ha), Burgos (40.731 ha), Huelva (14.992 ha), Abruzzo (4.718 ha) and the rape only in Pomurje (2.809 ha).*** The second most important oil plant used to be the rape, however the areas sawn with this species remained far beyond the sunflower and plays no important role for the biodiesel production in Ávila (53 ha) and Abruzzo (3 ha). However, in the Burgos province 560 ha of rape represents a certain pool for biodiesel. In the Pomurje region the sunflower represents with 154 ha the second most important oil plant.

Since all the five regions are known of their shortage of rain and water, the summarized crop yield data clearly shows the great influence of the irrigation on the average as well as total yield in the particular year and region. It was noticed that the lack of rain during the crop development had more limiting effect on the production than the proposed varieties. For preventing the great oscillation in the oil seeds, a stable biodiesel production can base on oil plant production from the irrigated land. However, only a small part of the sunflower is irrigated in Ávila (810 ha), Burgos (594 ha), Huelva (526 ha) and (ha) Abruzzo). On the other side, we must put out that at the moment the Pomurje has got no irrigated areas at all, and therefore it annual production varies the most.

The ***crop economic analysis*** showed that the costs differences are more due to the practices used in each cropland than because of their geographical and weather condition. For the Spanish agricultural practice in rape production the costs variation are mainly due to the preparation of land depth and the irrigation. Subsequently, the rape cultivation break-even point for Avila, Burgos and Huelva shows that it will not be profitable to returns under 1.141,5 Kg/ha in unirrigated land and under 1.768,5 Kg/ha in irrigated lands, before grants. For Pomurje the rape cultivation break-even point under unirrigated land lies under 1.536,8 Kg/ha. Since the sunflower usually reaches higher market prices, the cultivation break-even point for Avila, Burgos and Huelva lies below rape and it will not be profitable to returns already under 787,50 Kg/ha in unirrigated land and under 1.305,7 Kg/ha in irrigated lands, before grants. For Pomurje the sunflower cultivation break-even point under unirrigated land lies under 1.136,8 Kg/ha.

Biofuel production potentials differ from region to region and are the sum of the whole producer ability from every industrial facilities existing. At the moment, the factories production abilities in Avila are 70000 T/year, in Burgos 80.000 t/year, and Pomurje 6.000

t/year. However, in 2007 only about 2800 ha of sunflower and approximately 90 ha of rape will be processed into biodiesel in Burgos and 2.727 ha in Pomurje.

The ***biofuel producers' feasibility*** will certainly depend very much on prices level of diesel oil from petroleum in petrol stations, oil for food and especially the prices of other grain produce (maize, wheat). Because of that, the best chances to face this changing market will come from the Cooperatives (or entities including farmers in their projects) that have the chance to agrarian producers form part of global projects where there is a distribution of profits between both parts and both of them satisfy their profitability needs.

- Acceptability from farmers and potential of available to crop area and potential of oils production
- Sustainability indicators, energy and environmental balances, and impact of these crops on soil diversification and fertility

The success of introducing more biofuels in all regions involved in the project will depend not only on the cultivations agronomic practice, but also on the adaptation of different levels of risk their production implies such as the size of biofuels ability, education level and risk aversion of the agrarian businessman in order to ensure a crops better adaptation. Therefore, the aim of the strategies is not only to promote energy crops for obtain biodiesel as energy alternative on the local level, but also as a chance for the rural development. The ***defined strategies*** can be summarized as follows:

- To promote medium sized facilities linked to grain production and self-consumption, as prototype of biodiesel producer
- Actions focusing at farmers in order to ensure production and consumption
- Improvement of energy balances on biodiesel production
- Promote R&D in vegetal and industrial production fields
- Education and continuous advice to farmers, bio-fuel producer and consumer